APH LIGHT SENSOR MANUAL

by

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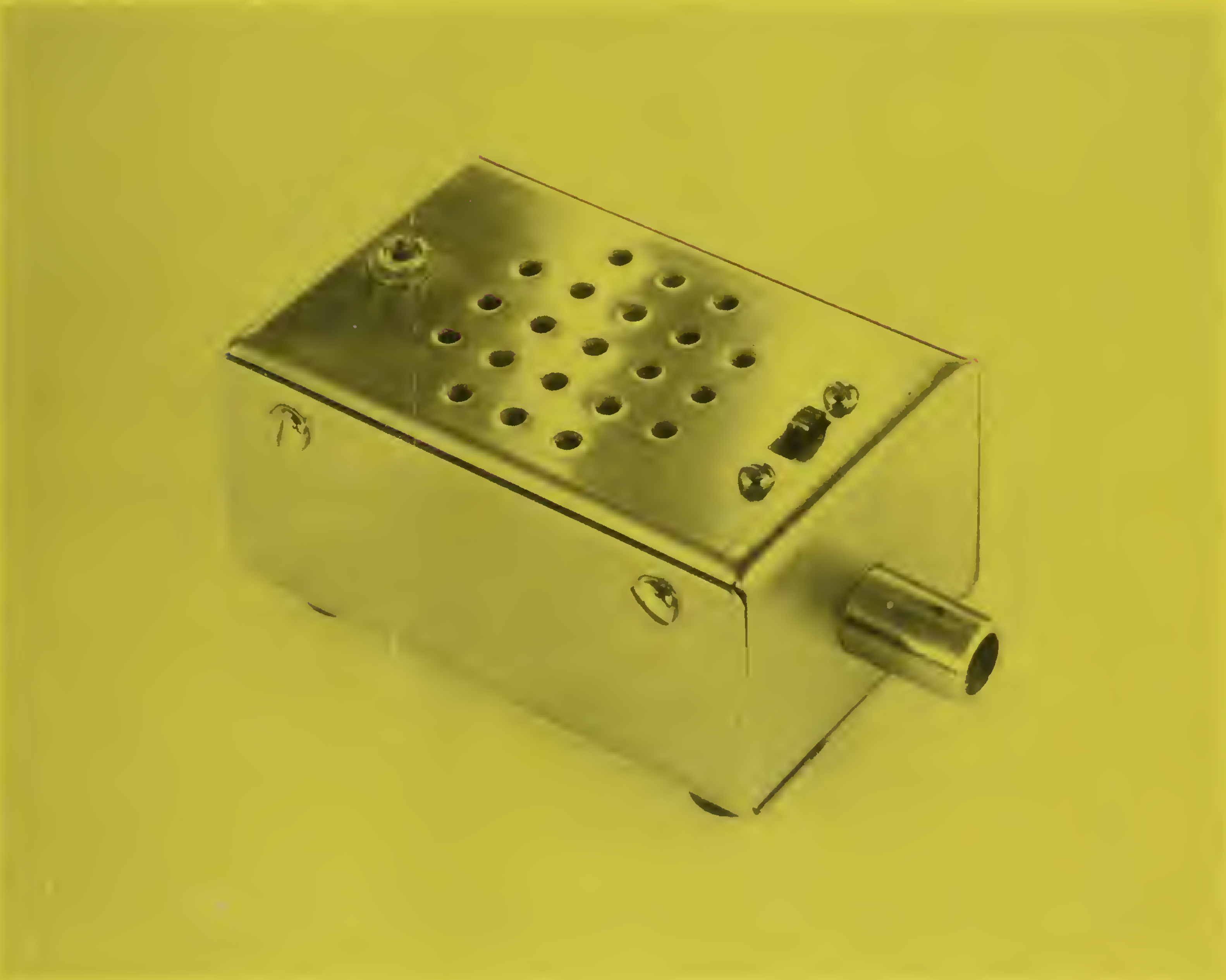
Department of
Educational Research



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TO EDUCATORS WHO USE THIS MANUAL

We will appreciate your assistance in helping us revise this manual for a subsequent printing. Please send us any suggestions you have for revising the experiments in this edition and/or for expanding the manual. We will include additional experiments which your blind students are able to perform successfully using the light sensor if you will send them to us. You may use the format followed in this edition. Include illustrations when appropriate. Please indicate the grade level, mode of reading (e. g., braille, large print), and number of students who perform each experiment.

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Acknowledgments

A delay in adaptation and distribution of a light sensor by the American Printing House for the Blind (APH) has occurred because of the lack of availability of an adequate light probe or sensor in the United States. The Royal National Institute for the Blind—England (RNIB) light probe was used in a feasibility study which supported the effectiveness of such an aid for use by blind students. (The RNIB light probe is cylindrical and rolls or moves when touched or placed on an uneven surface.) Subsequently, a rectangular prototype was developed for APH through Lawrence Hall of Science (University of California, Berkeley). Final adaptations made to this prototype have resulted in the development of the APH light sensor.

We appreciate the cooperation of the following teachers who participated in the feasibility study:

Mr. A. H. Evancic
Western Pennsylvannia School for Blind Children

Mr. Ross L. Huckins
California School for the Blind

Mrs. Marian Lewis
Tennessee School for the Blind

Mrs. Elise Nichols
Tennessee School for the Blind

Mrs. LaRhea Sanford
Florida School for the Deaf and the Blind

Mr. Norman Anderson
Maryland School for the Blind

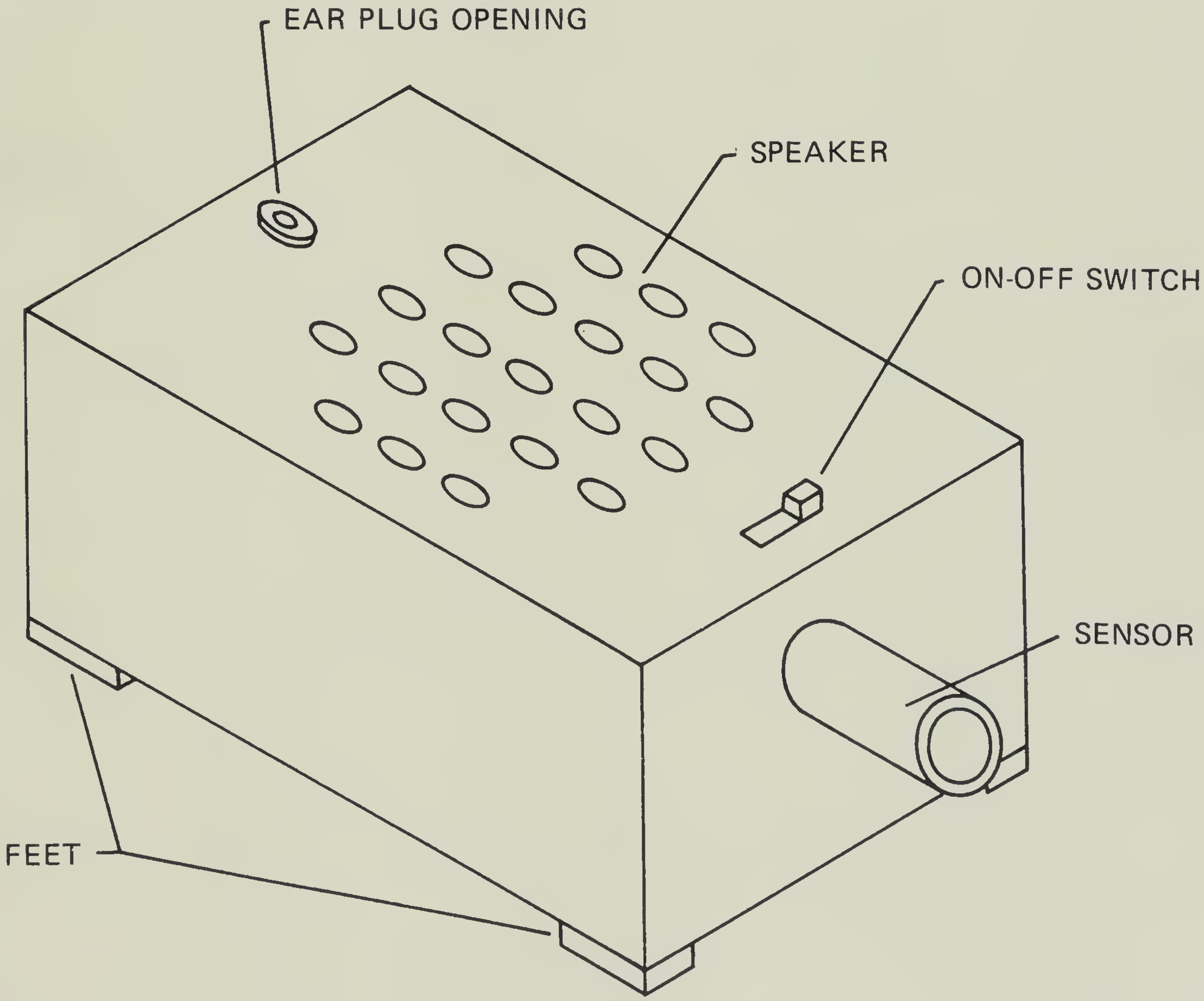
Many science operations in laboratory science cannot be demonstrated to or accomplished by young blind students because of the lack of appropriate educational aids required to perform numerous highly visual tasks. The lack of these aids has severely restricted direct exploration, experimentation, and discovery in laboratory science for the young blind student. Attempts to alleviate this problem have resulted in the development of the APH light sensor. The sensor is expected to result in the broadening of direct interaction in and exploration of highly visual concept areas in laboratory science which previously have not been open to young blind students The purpose of the "laboratory manual" accompanying the light sensor is:

1) To introduce basic science concepts to young blind students utilizing a laboratory approach, and
2) To teach the use of the light sensor as an aid in laboratory science through performance of simple experiments.

For clarity, each experiment is presented as a single concept. The caption for each experiment is located under the page number on the right-hand side of the page.

The APH light sensor

No training program is included for teaching use of the light sensor. Because of the range in age and ability of young blind students, it was not possible to prepare an adequate across-the-board training program. Operational and moving parts should be taught initially, but emphasis should be on operation rather than on definition of terms. Illustration 1 below shows the light sensor and identified its operational parts.



APH LIGHT SENSOR

The experiments are arranged in order of suggested presentation to young blind students. However, they do not necessarily represent a sequential presentation according to difficulty level. If certain aspects of some experiments are too difficult, simplify or break down the tasks. If vocabulary is too difficult, simplify or delete troublesome terms. Encourage maximum participation by the blind student. Upon completion of an experiment, proceed to the next experiment. The arrangement and content do not foster random selection of experiments. It may be helpful to think of these experiments as composing the young blind student's first "lab manual."

Collecting and recording data is left to the discretion of the teacher. Very young blind students will not have mastered the communication skills required for reading the experiments and for recording results of the various tasks performed. Hopefully, their introduction to laboratory science will not be deferred until mastery of these communication skills is achieved.

The experiments. The first four experiments introduce light intensity and its relation to the pitch and frequency of sound from the light sensor. Intensity of light is explained in terms of the amount of light from a light source–bright light, dim light. Absence of light is explained as dark or shadow. Pitch is introduced as high and low sound, and frequency of sound is introduced when students become aware of the change in frequency which occurs with the change in pitch. To reduce the number and difficulty of new terms the student has to learn, the introduction of such terms as "pitch" and "frequency" are left to the discretion of the teacher. Although light and dark shades of clothing are introduced, the teacher should avoid identifying color. The sensor reacts only to light intensity and no attempt to specify colors should be made. Confusion for totally blind students may result from comments by low vision students on particular colors of clothing items. Caution and care should be exercised by the teacher regarding color.

Experiments 5 and 6 introduce heat expansion and contraction using a coolant. It may be necessary for the teacher to partially assemble some of the apparatus for this experiment. The young blind student should be able to perform basic tasks which teach him the concepts of expansion and contraction.

Experiments 7 through 9 utilize a light source and a large APH relief globe to introduce the student to concepts of daylight and darkness (increasing and decreasing amounts of light caused by rotation of the earth). The very young blind student may require a partner or assistance from the teacher in holding the sensor at the correct angle and in moving around the globe.

Experiments 10 and 11 introduce oxygen and carbon dioxide. Striking matches and lighting candles are tasks included. Some very young blind students may be able to learn to perform these tasks: others may require assistance. Even with assistance, students should be able to perform enough tasks to comprehend on an operational level the concept specified in each experiment.

Experiment 12 presents an experiment in determining the amount of material in a transparent container using the light sensor. Although this is a simple visual task for a sighted student, it becomes considerably more difficult for the blind student who is relying on a light sensor to find the water or surface level in the container. "Amount" in this experiment refers very generally to the area of the container which is covered or filled by the material. Measurement experiments can be introduced when the student is ready.

Experiment 13 introduces the concept of evaporation. Evaporation can be increased (for older students) with the use of a hot plate or heat source.

Experiments 14 through 20 introduce a group of experiments including transparency of clear water, introduction of various sediments and pollutants into water, and finally purification of polluted water. This group of experiments affords the teacher the opportunity of building an instructional unit on pollution. Field trips and other resources can be employed to enrich and augment instruction. Students may be able to work independently or with partners performing several of the experiments.

Experiments 21 through 25 introduce additional basic concepts which appear in the elementary science curriculum. These include liquid displacement, breaking-up of a molecule, acids and bases, a test for starch, and photosynthesis. Some of these experiments are more complicated and may require additional teacher assistance. However, all experiments have been performed with primary grade students participating.

Suggestions for use. The following suggestions are included for the teacher who is using the laboratory manual for the first time.

1) Examine the light sensor and become familiar with its operation before teaching students to use it.
2) Practice manipulating and performing simple tasks with the light sensor using sleep shades or blinders.
3) Perform—or at least think through—each experiment prior to student performance.
4) Expand the experiments to include additional concept-related activities (e.g. student-initiated experiments), field trips (e.g. water purification plant), and discussion of current problems related to science (e.g. water pollution).
5) Allow students to participate in as many tasks as they can perform, independently or with assistance. **Teacher demonstration is not enough.**
6) Promote individual student exploration in laboratory science and student development of simple laboratory experiments using the light sensor.
7) Provide additional time and opportunity for direct inspection and exploration for totally blind students. The light sensor was developed primarily to meet specific needs of this population.
8) Encourage students to verbalize the tasks they perform (what they do), to explain the results of their performance (what happens), and to begin to draw simple conclusions (what the experiment shows—the concept taught).

Concept 1

The sound from a light sensor changes as the amount of light from the light source changes.

Vocabulary

Light sensor

Light source

Bright light

Dim light

High sound

Low sound

Names of the parts of the room (e.g., ceiling, window)

Equipment

APH light sensor

Light source

Experiment

Look at the light sensor. Examine it closely. Turn it on and off. Find the place where the light comes into the sensor. Find the place where the sound comes out. What is the shape of the light sensor? How many sides does it have?

Point the sensor at different objects in the room. Notice the change in sound as you point the sensor at different parts of the room. When you point the sensor toward a light source, the sound becomes higher. When you point the sensor away from a light source the sound becomes lower.

Point the sensor toward the ceiling. Turn the ceiling light on and off a few times. Notice the change in sound. Turn the light on. Can you find the exact position of the light source on the ceiling?

Point the light sensor: toward the floor, under a table, up and down in a closet. Note the sound differences. Where is the sound highest in the room? Where is it lowest?

Try using the light sensor outside in the sunlight and in the shade. Can you find the location of the sun using the light sensor?

Concept 2

Light and dark shades of clothing can be detected using the light sensor.

Vocabulary

Light sensor

Shade

Reflect

Equipment

APH light sensor	Light source

Experiment

Point the light sensor at your clothing. Notice the change in the sound as you observe your shirt and pants. When you point the sensor toward light colored clothing, the sound becomes higher. When you point the sensor toward dark colored clothing, the sound becomes lower.

Observe the clothing of your classmates. Check shoes, sox, and other small pieces of clothing (e.g., handkerchief, scarf).

Can you pick dark colored sox from light colored sox? Place them in two groups. (Light and dark cloth patches can be substituted for sox.)

Concept 3

Shadows appear when objects are placed between a light source and a screen.

Vocabulary

Light sensor

Light source

Shadow

Equipment

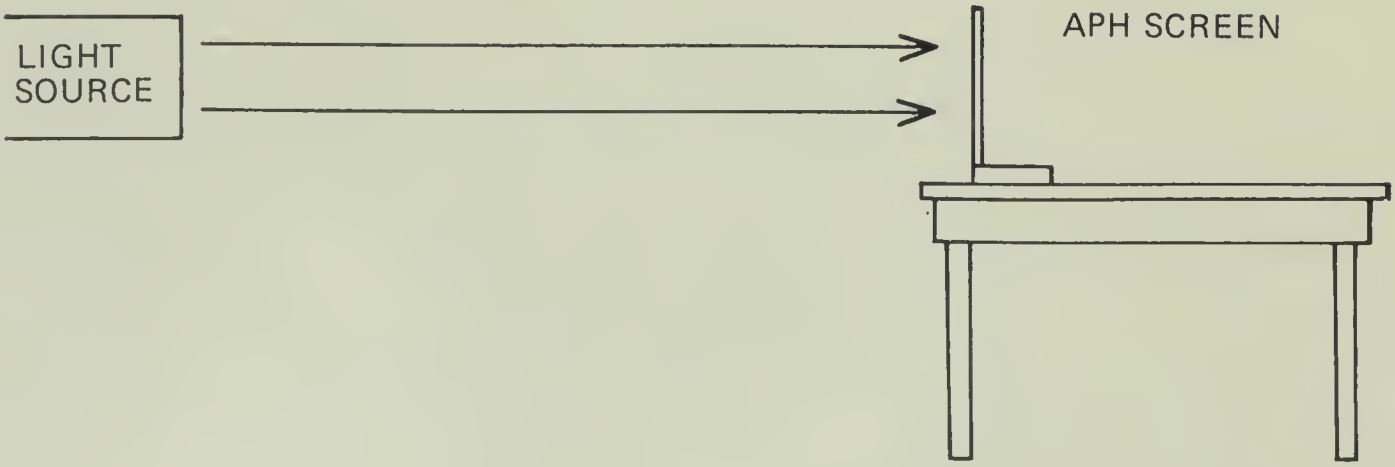
Screen

Light source

APH light sensor

Experiment

Set up a screen as shown in the illustration below. Turn on the light source. Point it toward the screen. Select a partner. Have your partner make a shadow by holding an object between the light source and the screen. Use the light sensor to find the shadow on the screen. Take turns making and finding shadows.



Use an object with a hole in its center. Hold the object so that light passes through the hole onto the screen. Can you find the light spot on the screen which is in the center of the shadow?

Concept 4

The size of a shadow on a screen can be changed by moving an object closer to or farther from a light source.

Vocabulary

Light sensor

Light source

Shadow

Equipment

APH light sensor	Light source
Screen	

Experiment

Set up a screen. Turn the light source on and point it toward the screen. Select a partner. Have your partner make a shadow by holding an object between the light source and the screen. Hold the object near the screen. Use the light sensor to find the shadow on the screen. Notice the size of the shadow. (See the illustration in **Concept 3**.)

Have your partner hold the object at different distances near and far from the screen. What happens to the size of the shadow? When is the shadow largest? When is it smallest?

Take turns performing the experiment. Use different objects in the classroom.

Concept 5

The liquid in a themometer (glass tube) expands when heated.

Vocabulary

Thermometer

Expand

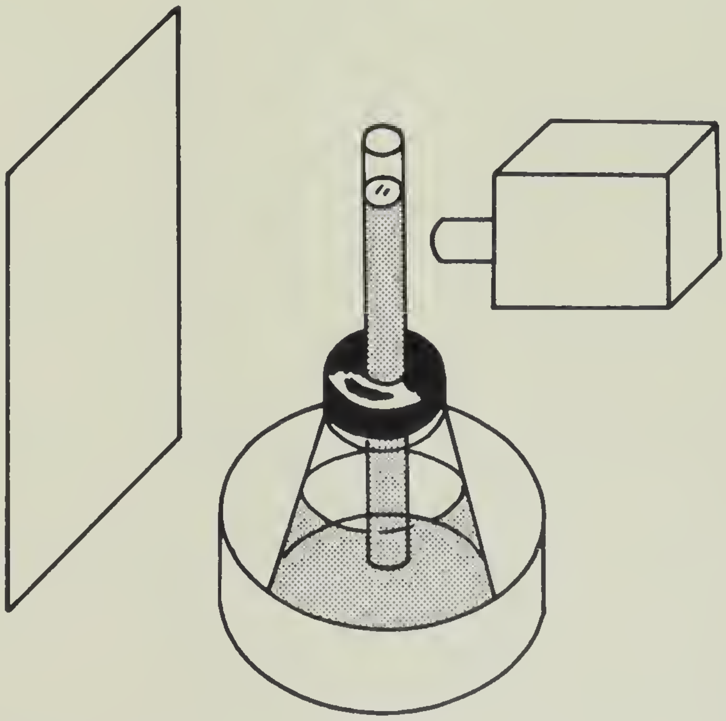
Insert

Equipment

Flask	Colored water
12-inch glass tube	Medicine dropper
White card	APH light sensor
One-hole rubber stopper to fit the flask	

Experiment

Fill the flask with colored water. Moisten the glass tube and the rubber stopper with water. Insert the glass tube into the hole of the stopper with a twisting motion. Insert the stopper into the flask. Place the flask in a pot of warm water. Now place the white card behind the thermometer as illustrated below. Use the light sensor to observe changes in the liquid in the tube.



Does the liquid go up or down when the water in the flask is heated? The heat has caused the water to expand and go up higher in the glass tube.

Concept 6

The liquid in a thermometer contracts when cooled.

Vocabulary

Thermometer

Contract

Equipment

Use the equipment as set up in the previous experiment.

Experiment

Add ice to the pan of water that your thermometer is in. Use the light sensor to observe the change in the height of the liquid in the tube. Does the liquid go up or down when the water in the flask is cooled?

The ice has caused the water to contract and go lower in the glass tube.

Concept 7

The sun shines light on only one-half of the earth at a time.

Vocabulary

Morning

Noon

Afternoon

Equipment

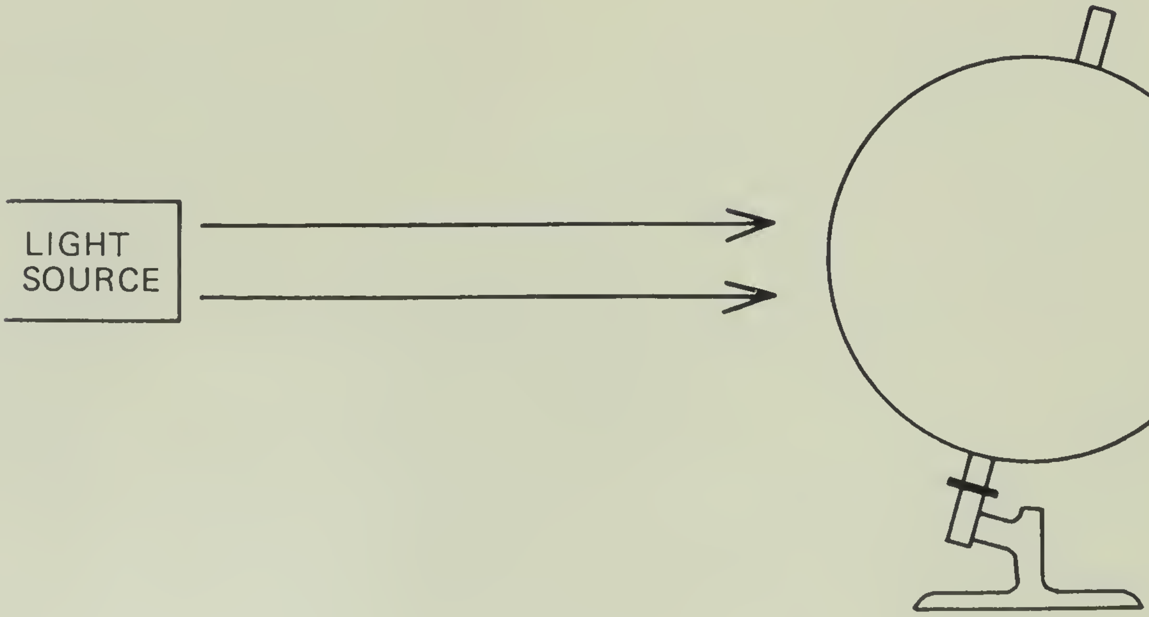
Large APH globe

Light source

APH light sensor

Experiment

Darken the classroom. Turn on the light source and point it toward the globe as illustrated below. Stand near the globe. Point the light sensor toward the globe. Move around the globe in a circle. Continue to face the globe as you move around it. Find the light side or day side of the earth. Be careful not to block the light source as you move.



Concept 8

The earth blocks the sunlight which causes darkness on one side of the earth.

Vocabulary

Shadow

Darkness

Midnight

Equipment

Large APH globe

APH light sensor

Light source

Experiment

Darken the classroom. Turn on the light source and point it toward the globe. Stand near the globe. Move around the globe in a circle. Continue to face the globe as you move around it. Find the dark side of the earth.

Midnight is the middle of the night. Where on the dark side of the globe do you think it is midnight?

(See the illustration in **Concept 7.**)

Concept 9

The rotation of the earth causes an increase in the amount of light in the morning and a decrease in the amount of light in the evening.

Vocabulary

Increase

Decrease

Light sensor

Rotation

Equipment

Large APH globe

Light source

APH light sensor

Experiment

Darken the classroom. Turn on the light source and point it toward the globe. Point the light sensor at the globe. Walk around the globe several times. Notice the changing sounds made by the light sensor.

Observe morning. Stand on the dark side of the globe. Point the light sensor at one point on the globe and turn (rotate) the globe. Hold the light sensor at the same point as you walk around the globe. Can you hear a change in the sound made by the light sensor? Is the sound higher or lower? Morning is a time of increasing amounts of sunlight. The sound of the light sensor gets higher as the amount of light increases.

Observe evening. Stand on the light side of the earth. Point the light sensor at a point on the globe and turn (rotate) the globe. Hold the light sensor on the same point as you walk around the globe. Can you hear a change in the sound made by the light sensor? Is the sound higher or lower? Evening is a time of decreasing amounts of sunlight. The sound of the light sensor gets lower as the amount of light decreases.

(See the illustration in **Concept 7**.)

Concept 10

Fire needs air (oxygen) to burn.

Vocabulary

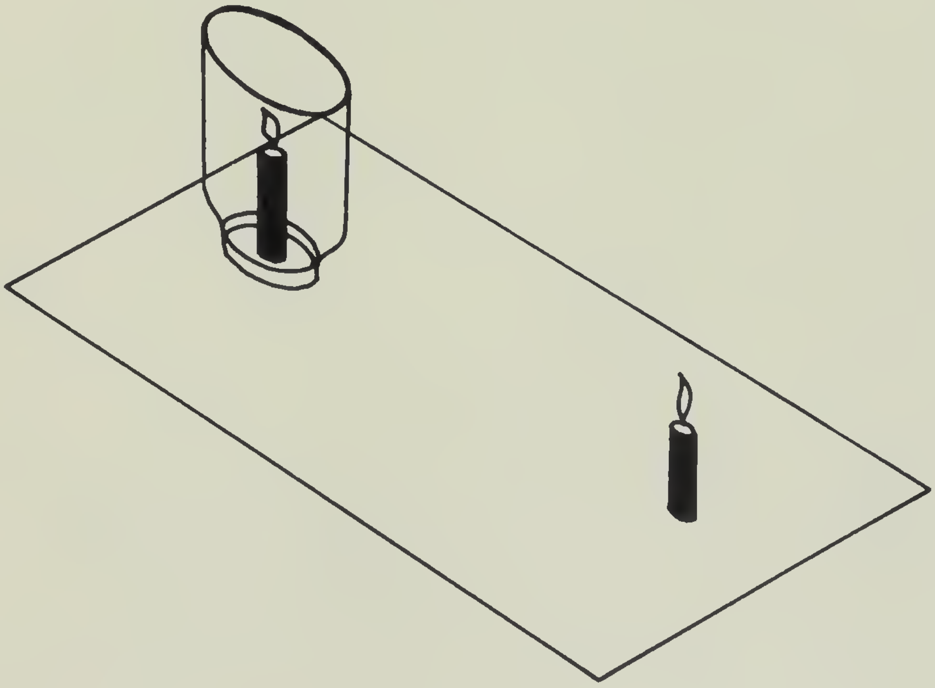
Oxygen

Equipment

2 birthday candles	Matches
Olive jar	APH light sensor
Piece of cardboard	

Experiment

Stand two birthday candles on a piece of cardboard. (You may need to heat the ends of the candles so they will stand.) Light the candles. Turn the light sensor on. Cover one of candles with the jar as illustrated below. Use the light sensor to observe the candle burning under the jar. What happened to the candle under the jar? Observe the other candle. What happened to the candle without the jar?



Try different sizes of jars. Observe what happens. Try to put the jars in order from the one that lets the candle burn the longest length of time to the one that lets the candle burn the shortest length of time.

Concept 11

Carbon dioxide can extinguish a fire.

Vocabulary

Carbon dioxide

Vinegar

Baking soda

Extinguish

Equipment

Baking soda

Vinegar

Empty quart coke bottle

Matches

Measuring cup

APH light sensor

Funnel

Light source

Experiment

Select a partner.

Pour one-half cup of baking soda into the coke bottle. Use a funnel. Now pour one-half cup of vinegar into the bottle.

Hold the bottle near the opening with one hand. Hold the light sensor in the other hand. Point the light sensor toward the opening of the bottle. Have your partner strike a match and hold the flame over the opening of the bottle. What happens to the flame? Strike more matches. Count how many matches the carbon dioxide from the bottle puts out.

Concept 12

The amount of material inside a container can be determined by using a light sensor.

Vocabulary

Depth

Solid

Liquid

Water level

Equipment

Clear container

Food coloring

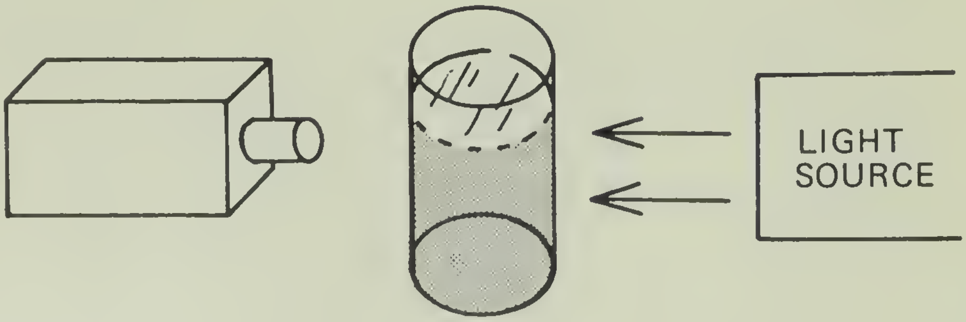
Variety of dry materials (flour, sugar, gravel)

Water

APH light sensor

Experiment

Pour some water and food coloring in the container. Point the sensor up and down the side of the container. Find the water level of the colored liquid in the container. Where does the top of the water meet the air above it?



Repeat the process, using various solids.

Concept 13

Water can go into the air or evaporate.

Vocabulary

Evaporate

Water level

Equipment

2 wide-mouth clear containers of the same size

APH light sensor

Light source

Colored water

Cover for one container

Tape

Experiment

Fill the two containers about one-half full of colored water. Use containers which have wide tops so the water will evaporate faster. Put both containers in a warm, sunny place. Cover one container. Measure the water level in each container using the light sensor. Mark the level with tape on the side of the containers. Measure the water level every other day. Mark the water level with tape when about one-half of the water is gone in one container. Mark the water level again when only one-fourth of the water remains.

How long does it take for the water in the open container to evaporate? How much water remains in the container which has the top on it?

Concept 14

Water is clear or transparent.

Vocabulary

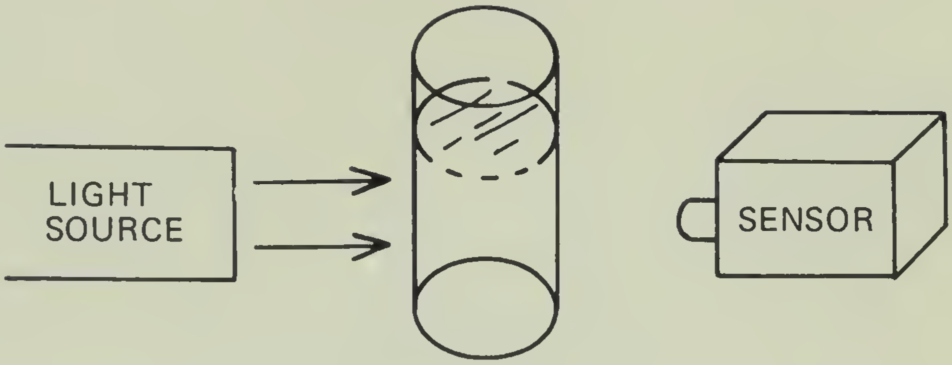
Transparent

Equipment

APH light sensor	Light source
Jar	Water

Experiment

Fill a jar with water. Place the jar of water between a light source and a light sensor as illustrated below. Does the light pass through the jar?



Water is called transparent because it lets the light pass through.

Concept 15

Milk is semitransparent.

Vocabulary

Semitransparent

Equipment

Jar

1/2 pint milk

Water

APH light sensor

Light source

Experiment

Fill the jar with milk. Place the jar of milk between a light source and a light sensor as illustrated in Concept 14. Does the light pass through the milk?

Compare the jar of milk and a jar of water. Which one lets more light through?

Try other liquids and identify those which are semitransparent.

Liquids like milk are called semitransparent because they let some—but not all—of the light pass through.

(See illustration in **Concept 14.**)

Concept 16

Dirt is opaque.

Vocabulary

Opaque

Equipment

Jar

Dirt

APH light sensor

Light source

Experiment

Fill a jar with dirt. Place the jar of dirt between the light source and the light sensor as illustrated in Concept 14.

Does the light pass through the dirt in the jar?

Try some other opaque materials.

These materials are opaque because they do not let the light pass through.

(See the illustration in **Concept 14.**)

Concept 17

Pollutants mixed with water reduce the transparency (or clearness) of the water.

Vocabulary

Pollutants

Transparency

Equipment

Quart jar	Measuring cup
APH light sensor	Funnel
Water	Light source
Soil	Pollutants (e.g., egg, egg shell, paper, milk, dirt, oil, coffee grounds)

Experiments

Pour 2 1/2 cups of water into the jar. Pour a cup of mixed pollutants into the jar. Use the funnel if necessary. Shake the jar to mix the pollutants and water. Place the polluted water between the light source and the light sensor as illustrated in Concept 14. Use the light sensor to check the transparency.

Now compare the polluted water with a jar of clear water. Which is more transparent? That is, which one lets more light through?

(See the illustration in **Concept 14**.)

Concept 18

Some pollutants float and some sink to the bottom of a jar when mixed with water.

Vocabulary

Pollutants (pollution)

Float

Suspend(ed)

Equipment

APH light sensor

Jar of polluted water

Light source

Experiment

Let the polluted water stand overnight. Place the jar of polluted water between the light source and the light sensor as illustrated in Concept 14. Place the light sensor perpendicular to the side of the jar. Move the light sensor up and down the side of the jar. Is there a difference in the sound made by the light sensor as you move it up and down? Did the water become clearer after standing overnight? Did some of the pollutants sink to the bottom of the jar? Did some of them float? Are any suspended between the top and the bottom of the jar?

(See the illustration in **Concept 14**.)

Concept 19

Dirt sinks to the bottom of a jar when mixed with water.

Vocabulary

Soil

Mix(ed)

Sediment

Equipment

Quart jar

APH light sensor

Water

Light source

Soil

Measuring cup

Funnel

Experiment

Pour 2 1/2 cups of water into the jar. Pour 1 cup of soil into the jar. Use the funnel if necessary. Shake the jar to mix the soil and water. Place the jar of mixed soil and water between the light source and the light sensor as illustrated in Concept 14. Observe the mixture of soil and water. Note the sound made by the light sensor.

Let the water stand for 5 minutes. The soil sinks to the bottom of the jar. Use the light sensor to observe the sediment on the bottom of the jar. With a piece of tape, mark the dirt or sediment level.

Let the water stand overnight. Now observe the layer of sediment. Is the layer of sediment in the bottom of the jar higher than the day before?

Retain the soil and water mixture for the next experiment.

(See the illustration in **Concept 14**.)

Concept 20

Water can be purified by filtration.

Vocabulary

Purified

Filtration

Equipment

Tall jar or test tube

Funnel

Cotton ball

Tap water

Sand

APH light sensor

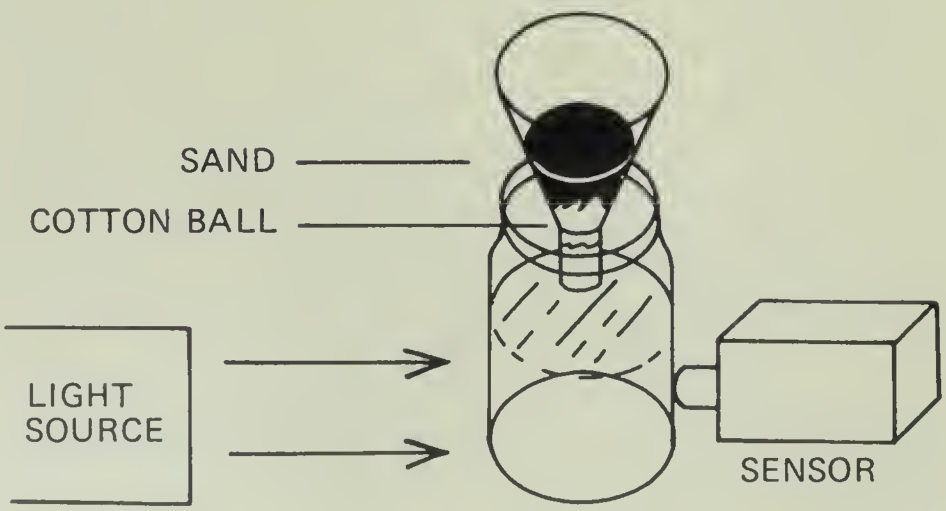
Mixture of soil and water

Light source

Experiment

Make a filter. Place a cotton ball in the funnel. Put a layer of sand about one inch (3 cms) deep over the cotton. Place the funnel in a clean jar.

Gently pour some of the mixture into the funnel. Let the water drain into the jar. Place the container of filtered water between the light source and the light sensor as illustrated below. Compare the filltered water to a container of tap water.



What happened to the water that passed through the filter in the funnel?

You have made a simple model of a water-purifying plant. How do you suppose germs can be killed or removed from the water?

Concept 21

A solid object displaces water.

Vocabulary

Displace

Solid

Water level or surface level

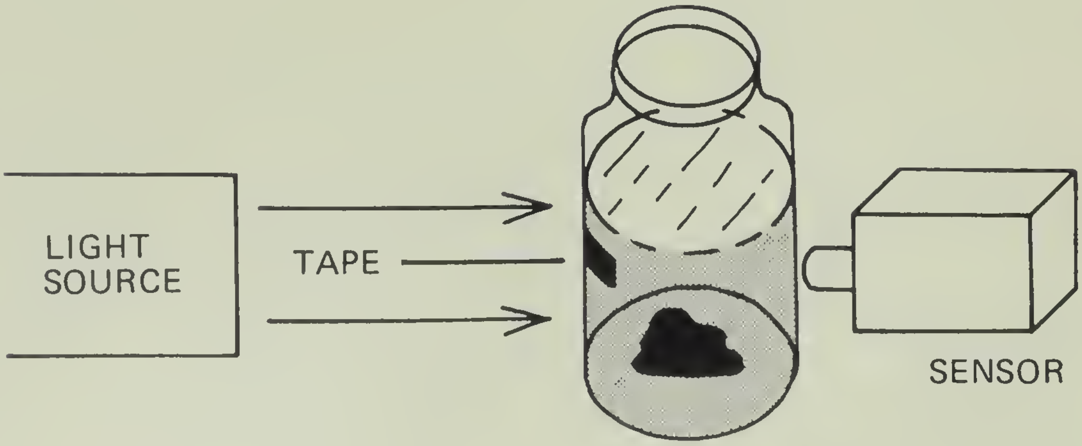
Equipment

A quart clear container	Colored Water
APH light sensor	Tape

1 large rock or brick which will fit into the container

Experiment

Fill the container about half full of colored water. Use a light sensor to find the water level or surface level of the water in the container. Mark the water level with tape. Carefully put the rock or brick into the container. Use the light sensor to see how much the water level has changed.



Repeat the experiment using other materials (e.g., wood, cork). Is there a difference in the amount of water that these solid objects displace? Why is there a difference?

Concept 22

Some molecules can be broken up by heat.

Vocabulary

Molecule

Moisture

Condensing

Inverted

Substances

Equipment

Sugar

Teaspoon

Small aluminum foil pan

White construction paper

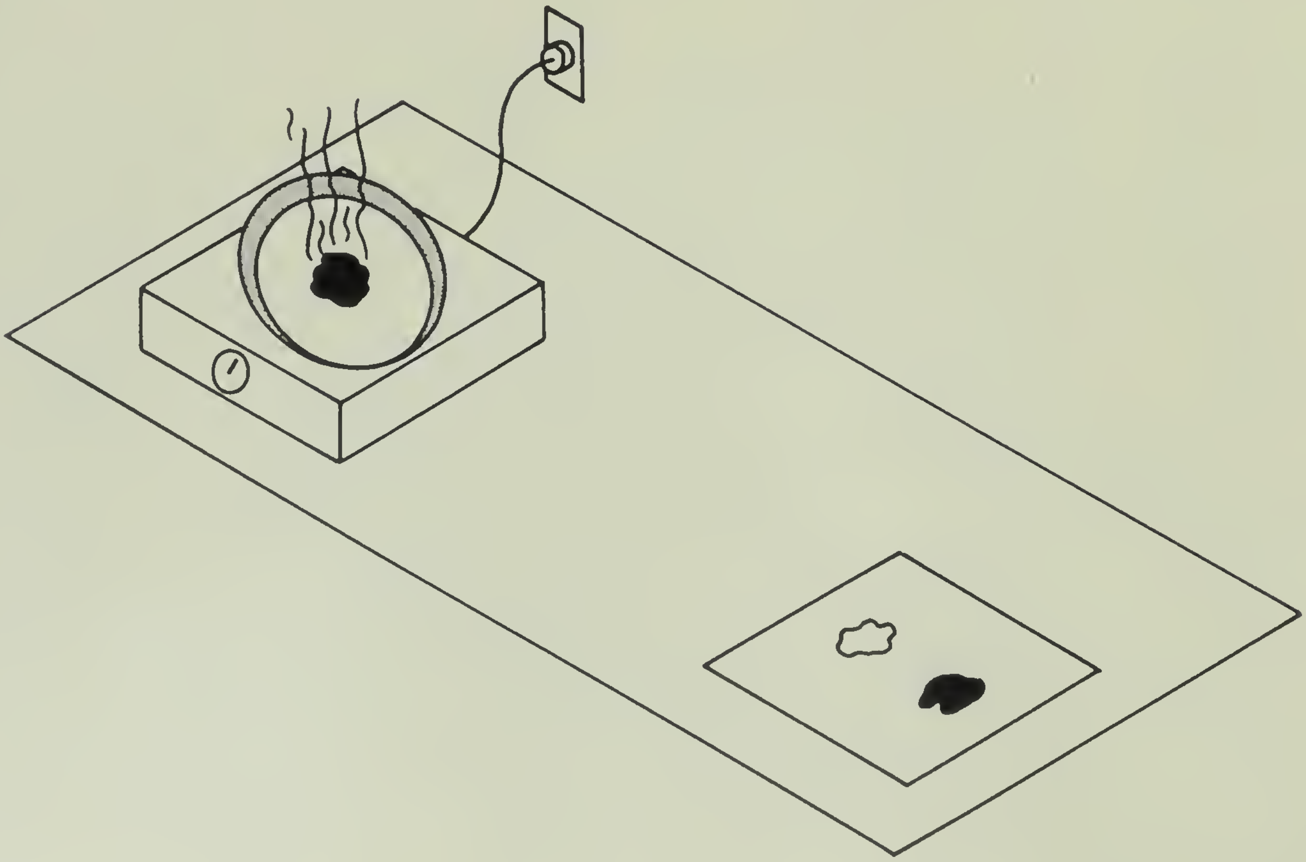
Hot plate

Glass

APH light sensor

Experiment

Put 3 teaspoonfuls of sugar into an aluminum foil pan. Heat the sugar on a hot plate. Do you notice any sound or smell as the sugar gets hotter?



When the bubbling stops, let the burned sugar cool. Scrape some of the burned materials onto a piece of white paper. Feel the sugar. Does it feel different than before it was heated? Place a spoonful of sugar on the paper near the burned sugar. Use the light sensor to observe the two substances. Does the light sensor give the same sound for each?

What has happened to the burned sugar?

Concept 23

Litmus paper changes color when placed in acids and bases.

Vocabulary

Litmus paper

Acid

Base

Neutral

Equipment

Red litmus paper

Blue litmus paper

Various solutions of acids and bases

(Exercise caution in selecting appropriate acids.)

APH light sensor

Light source

Experiment

Arrange several solutions of acids and bases labeled in braille using dymotape or brailled cards taped to the beakers.

Dip one end of a piece of litmus paper half way into the solution. Use the light sensor to see if the paper produces the same pitch along its entire length.

What happened to each color of litmus paper when you put it in the liquid?

Test each solution with both colors of litmus paper to determine if some of the solutions are neutral.

Concept 24

A food contains starch if a blue-black color appears after the application of a few drops of iodine solution.

Vocabulary

Carbohydrate

Iodine solution

Starch

Equipment

Iodine solution

Medicine dropper

Evaporating dishes

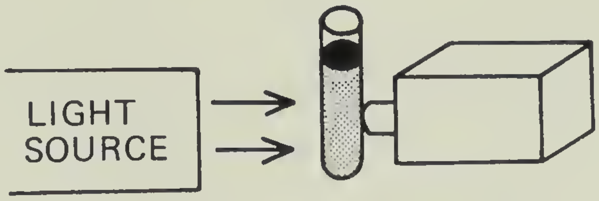
APH light sensor

Test tube

Bread

Experiment

Fill a test tube with the iodine solution. Place the test tube between a light source and a light sensor as illustrated below. Now place the light sensor perpendicular to the test tube. Note the sound made by the light sensor.



Remove the crust from the bread. Place two pieces of bread in an evaporating dish. Put a drop or two of iodine solution on one of the pieces of bread. Use the light sensor to observe the bread. Does the iodine cause a difference in the sound? Iodine turns blue-black in the presence of starch. Is there starch present in the bread?

Try other foods. Find out if cooking makes a difference.

Concept 25

Although the first food to be made by green plants is glucose, some of it soon changes to starch, which can be detected by an iodine solution.

Vocabulary

Photosynthesis
Iodine solution
Chlorophyll
Starch
Glucose
Alcohol
Geranium
Food

Equipment

Geranium plant
Rubbing alcohol
Black carbon paper
Paper clips
APH light sensor
Iodine solution
Hot plate
Medicine dropper
Evaporating dish
Beakers (2 sizes)
Light source

Experiment

Fold three pieces of black carbon paper so that each piece will slip around a geranium leaf. Slip each folded piece of black carbon paper around a leaf so that no light can get to the leaf. Use paper clips to hold the paper securely. Record the date.

After seven days, take the black carbon paper off one leaf and remove the leaf from the plant. Heat some alcohol in a beaker over boiling water until it boils. Break a green leaf which has been in the sun from the geranium plant. Label and place them in the boiling alcohol until the chlorophyll has been removed. Quickly remove the leaves from the alcohol and put them in a basin of hot water. Remove both leaves from the water and place them in an evaporating dish. Cover the leaves with iodine solution and leave for several minutes. Use the light sensor to compare the color reaction of the two leaves.

Five days later take the paper off the second leaf and repeat the procedure.

Do not remove the black carbon paper from the third leaf until it falls from the plant. Use a light sensor to compare the third leaf with a green leaf taken from the plant.

Do the leaves which you are comparing feel different?